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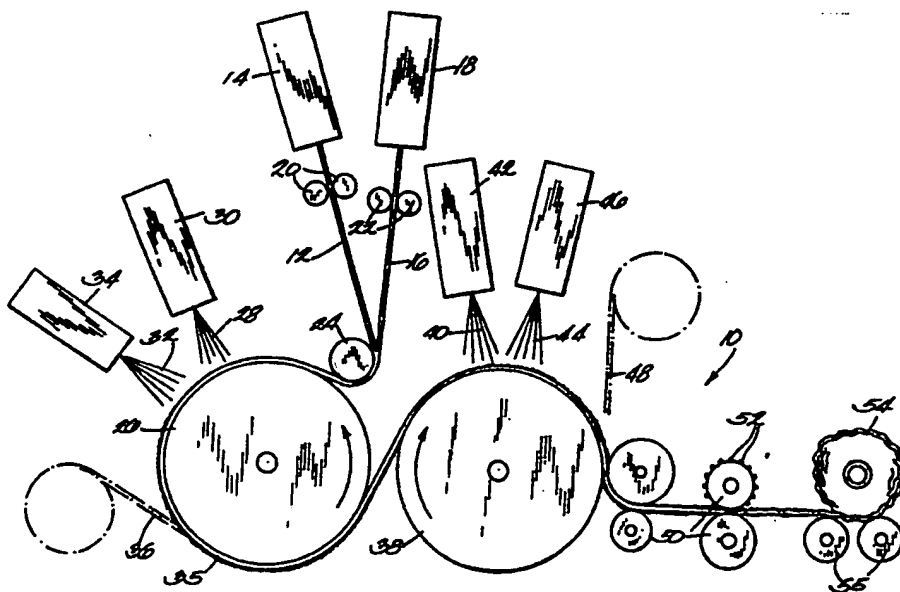
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(54) Title: ELASTICIZED FABRIC WITH CONTINUOUS FILAMENTS AND METHOD OF FORMING



(57) Abstract

A process for producing an elasticized fabric, including forming an array of elastomeric filaments (12) and generally an array of non-elastic filaments (16). The two arrays are combined with one or more layers of simultaneously formed webs of melt blown fibers (32, 44), and optionally prefabricated webs (36, 48). At certain points in the process the web is subjected to tension so as to elongate it and molecularly orient certain elements of the web. The web is then pin-bonded (50) or otherwise adhered together, and then relaxed so as to permit the formation of corrugations, wrinkles or gathers in the melt blown fibrous webs, and kinks, curls and undulations in the non-elastic continuous filaments.

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**ELASTICIZED FABRIC WITH
CONTINUOUS FILAMENTS AND METHOD OF FORMING**
Background of the Invention

5 This invention relates to an improved process and apparatus for preparing non-woven elasticized fabrics, and in particular to such a process and apparatus in which thermal and oxidative degradation are reduced substantially and wherein the web and fiber separation upon the application of a stretching
10 force is reduced.

 There has been a great need for a less critical process to produce elasticized webs having an improved quality and a predetermined controlled porosity for water repellency, breatheability and drapability at a lower cost than has been heretofore available. There is also a great need for a process which
15 does not degrade the elastomeric polymers to as great an extent as that which occurs in the melt blown or spray spun process during the formation of fibers or filaments, in order that lower cost elastomers may be
20 utilized.

 It has been known for some time that thermoplastic elastomeric polymers (TPE polymers) were con-

sidered too unstable for direct use at the high die and air temperatures required to produce melt blown elastomeric fibrous webs. Because high die and attenuating air temperatures are necessary to obtain viscosities required for good fiber formation or attenuation, and since large volumes of hot air are used for the fiber forming phase, the TPE polymer is subjected to both thermal and oxidative degradations which are a major cause or problem incurred in the melt blowing of TPE resins. Some types of elastomeric polymers lose their elasticity completely, while others which have been processed with viscosity reducing agents lose a portion of their elasticity. These latter polymers include low density, low molecular weight polyethylene such as USI's petrothene Na601 resin, and polypropylene such as Himont's PC 973. Some systems employ poly (alphamethylstyrene) materials such as Amoco 18-210, which allow extrusion at lower temperatures, whereby they retain varying amounts of their elastomeric properties. However, these blends, mixtures or premixed blends of polymers all suffer degradation to a certain extent.

Much work has also been done on various chemical systems in the initial resin material. These elastic polymers are called "block polymers", since the monomers involved are put together in separate blocks instead of single units. Some of the work related to block polymers is more fully described in the following patents:

Hazeltom et al., U.S. Patent No. 4,804,577; Taylor, U.S. Patent No. 4,781,966; Killian et al., U.S. Patent No. 4,724,184; Vander Wielen et al., U.S. Patent No. 4,720,415; Boggs, U.S. Patent No. 4,707,398; Morman, U.S. Patent No. 4,657,802; and Morman, U.S. Patent No. 4,652,487.

Other examples relating to melt blowing problems of elastomeric polymers, previously discussed, are more fully described in the following patents: Killian, et al. '184; Morman '802, at Column 11; and Jones et al., U.S. Patent No. 4,355,425.

Another method is the use of a blanket of inert gas to reduce the polymer oxidation, which is a major cause of the problems encountered in processing TPE polymers at the high temperatures associated in the fiber blowing phase of the melt blowing process. This blanketing of the resin in the fiber forming stage limits the oxidative degradation of the extrudable TPE resin.

Morman, U.S. Patent No. 4,692,371, at Columns 5, 6 and 7, describes a method for making an elastomeric material which may be heated to a temperature of about 600 (315°C) to form by extrusion through a plurality of extrusion orifices into a gas stream. The gas stream may be formed of an inert or at least a non-oxidizing gas such as nitrogen, which attenuates the extrudate from the orifices to provide elastomeric fibers using the melt blown process as described above and more completely described in Butin, U.S. Patent No. 3,849,241.

Morman '371, at column 7, describes the use of nitrogen gas as the heated attenuating gas stream to reduce the amount of oxidative degradation which the Kraton polymer undergoes during extrusion. Shell Chemical Co.'s Kraton GX 1657 block copolymer, when heated in air, showed a weight loss beginning at about 585°F (307°C) whereas when heated in nitrogen showed only a weight loss starting at about 707°F (375°C).

Boggs '398 at column 8 describes an Arnitel polyetherester being extruded in a temperature range of from about 349°F (176°C) to about 572°F (300°C),

with the heated attenuating gas being applied at a temperature of about 500°F (260°C) to about 572°F (300°C).

5 Killian, U.S. Patent No. 4,820,572, at columns 7 and 8, describes a Pebax polyether block amide which may be extruded within the temperature range of about 392°F (200°C) to about 662°F (350°C), at attenuating gas temperatures of about 572°F (300°C) to about 752°F (400°C).

10 In contrast to the high temperatures required to fiberize extrudable elastomers in the melt blown process, the Shell Technical Bulletin No. SC:1105-89 lists Kraton G2730X, Kraton G2731X, and Kraton D2120X as having melt temperatures of 408°F, 15 370°F, and 340°F, respectively. These temperature conditions are considerably lower than the previously described temperatures required for fiberizing elastomeric materials in the melt blown process.

20 The temperature conditions for extruding blown films are substantially the same as those required for melt spinning continuous filaments. The melt spun process consists of simultaneously spinning a multiple number of continuous filaments of a synthetic polymer such as polypropylene through a multi- 25 ple number of spinning nozzles or spinnerets, preferably extending in one or more rows. The polymer is melted in an extruder and the melt delivered by pumps to the spinning equipment which comprises spinning nozzles for the extrusion of molten polymer to form 30 the desired filaments and direct the filaments through a queen chamber into the nip of a pair of temperature controlled draw rolls which feed the downstream processing equipment. The melt spun process is explained more fully in Dorschner, U.S. Patent No. 3,692,618, 35 and Sabee, U.S. patent No. 4,910,064. Both patents

are incorporated by reference in their entirety.

Th melt spun process permits the use of much lower temperatures for processing extrudable thermoplastic polymers than does the melt blown process, the reason being that the melt spun process requires temperatures only high enough to melt the polymer to extrusion temperatures, whereas the melt blown process requires much higher temperatures in order to thermally degrade the polymer to fiberizing viscosities and to provide the high temperature, high velocity air streams necessary to attenuate and fiberize the molten and degraded fiber forming polymer, all of which is described in more detail in Butin '241 which is incorporated herein in its entirety by reference.

The melt blown process presents more difficulties in the preparation of uniform webs than does the melt spun process for the following reasons.

1. In addition to the high temperature degradation problems of the melt blown fiberizing process, there are problems associated with the uniformity of the fiber deposition on the foraminous collector surface, in that there is a tendency for lower or higher basis weight streaks to form in the webs.

2. Variations occur in the fiberizing air pressures and temperatures across the melt blown spinneret.

3. Variations occur in the melt blown polymer temperatures and degradation rate across the melt blown spinneret.

4. There is also the problem of roping, that is, the formation of "rope" which occurs when the heated gas flow rates are out of adjustment.

5. Another problem associated with the maladjustment of the gas flow rates is the production of objectionable coarse "shot" in the web when a uni-

5 form web is desired. Normal melt blown or spray spun
fibers vary in length from less than $\frac{1}{8}$ inch to sub-
stantially continuous filaments and have diameter
ranging from about 0.5 to about 100 or more microns in
10 diameter. "Shot", which is large globs of polymer
having diameters many times larger than that of melt
blown fibers, is objectionable because of its detri-
mental effects on product quality and costs, and is
discussed more fully in Butin '241. Continuous fila-
ments on the other hand are completely free of shot
and their accompanying surface imperfections upon cal-
endaring or embossing.

15 In addition to Butin '241, the above listed
problems are described in detail in the following U.S.
Patents all issued to Celanese Corporation and dis-
cussing apparatus and methods for spray spinning or
melt blowing molten fiber-forming materials: Lin,
U.S. Patent No. 4,240,864; McGinnis et al., U.S. Pat-
ent No. 3,849,040; Soehngen, U.S. Patent No.
20 3,749,633; Soehngen, U.S. Patent No. 3,740,302; Wag-
ner, U.S. Patent No. 3,543,332; and Soehngen, U.S.
Patent No. 3,444,863. All of these patents are incor-
porated herein in their entirety by reference.

25 The terms "melt blown fibers", "melt blown
filaments", "melt blown fibers and/or filaments",
"spray spun fibers", "spray spun filaments" and "spray
spun fibers and/or filaments" are herein used inter-
changeably, and are defined as melt blown fibers hav-
ing diameters varying from 0.1 microns or less to di-
30 ameters of more than about 2000 microns and having
lengths ranging from less than $\frac{1}{8}$ inch to continuous
filaments having extreme lengths. The melt blown or
spray spun process forms fibers or filaments of con-
tinuous or discontinuous lengths including shot, by
35 the extrusion of molten polymeric filaments from one

or more capillaries or orifices. Immediately upon emission from these capillaries, the lengths are attenuated by high temperature gas streams or gas jets, thereby forming fibers, filaments and under certain conditions undesirable course "shot" or "beads". This process is described in Van A. Wente, "Superfine Thermoplastic Fibers", Industrial and Engineering Chemistry, Vol. 48, No. 8, pp. 1342 to 1346, and in the above Celanese patents.

This invention relates to improvements over the methods and apparatus referred to above and to solutions to some of the problems raised or not solved thereby.

Summary of the Invention

The invention relates to a process for producing an elasticized fabric, and the fabric produced by that process. The invention includes forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments. In one embodiment the elastomeric continuous filaments are under tension and the non-elastic filaments are molecularly oriented. The two arrays are laid onto a first accumulating roll having a first peripheral velocity. A melt blown fibrous layer is deposited onto one side of the array of elastomeric filaments, thereby stabilizing the elastomeric filaments in their predetermined laydown orientation. Next the stabilized web is elongated between the first accumulating roll and a second adjacent accumulating roll having a second peripheral velocity greater than the peripheral velocity of the first roll, thereby stretching the elastomeric filaments. This further molecularly orients the non-elastic filaments and molecularly orients at least some fibers comprising the melt blown fibrous layer.

Thus is formed a tensioned elasticized web. A layer of adhesive fibers is deposited onto the other side of the tensioned elasticized web while simultaneously depositing a second fibrous web onto the layer of adhesive fibers. This forms a tensioned, coherent, unified elasticized fabric. The tensioned, coherent, unified elasticized fabric is then fed through a pair of temperature controlled thermal pin bonding rolls having projecting pins which further bond the stretched elasticized fabric with autogenous bonds. Finally, the tensioned elasticized fabric is relaxed, thereby forming corrugations, wrinkles or gathers in the melt blown fibrous webs.

An alternative embodiment calls for forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments wherein the elastomeric continuous filaments are under tension and wherein the non-elastic filaments are molecularly oriented, while simultaneously depositing one or more fibrous layers of melt blown polymeric fibers onto one or more temperature controlled accumulating surfaces. In this embodiment at least one fibrous layer of adhesive fibers is deposited onto at least one side of the elastomeric filaments and the non-elastic continuous filaments while simultaneously feeding one or more melt blown fibrous webs, along with the elastomeric filaments and the non-elastic filaments, between a pair of pressurized temperature controlled squeeze rolls. This has the effect of joining the melt blown fibrous webs, the elastomeric filaments and the non-elastic filaments to form a tensioned coherent unified elasticized fabric. The unified fabric is then relaxed as indicated above to form corrugations, wrinkles or gathers in the melt

blown fibrous web and kinks, curls and undulations in the non-elastic filaments.

5 In another embodiment, one or more arrays of relatively elastomeric continuous filaments are formed, without being subjected to tension while forming. A melt blown fibrous layer is deposited onto an accumulating surface. A melt blown layer of adhesive
10 fibers is deposited onto at least one side of the elastomeric filaments to stabilize the laydown orientation. The melt blown fibrous web and the stabilized elastomeric filaments are fed between a pair of pressurized temperature controlled squeeze rolls, thereby joining the melt blown fibrous web and the elastomeric
15 filaments, and forming a coherent elasticized unified fabric. The unified fabric incrementally drawn and elongated, stretching the elastomeric filaments and molecularly orienting the fibers of the melt blown fibrous web. The stretched unified elasticized fabric is then pin-bonded and relaxed as described above.

20 Other alternatives are available including feeding the tensioned elastomeric filaments and the non-elastic filaments, together with a melt blown polymeric fibrous layer, into the nip of two oppositely rotating accumulating rolls, thereby joining all
25 three to form a tensioned coherent unified elasticized fabric. Alternatively the elasticized fabric may be elongated through two or more differential velocity draw or stretch rolls thereby stretching the elastomeric continuous filaments, and molecularly orienting
30 at least a portion of the fibers of the melt blown fibrous web.

In one embodiment the fibrous layer of adhesive fibers is deposited onto one side of the elastomeric continuous filaments, one side of the non-elastic
35 continuous filaments, one side of a melt blown

fibrous web, and into the nip of a pair of temperature controlled nip rolls.

Yet another alternative embodiment calls for forming an array of elastomeric filaments under tension while simultaneously depositing first and second fibrous layers of melt blown polymeric fibers onto first and second accumulating surfaces. A fibrous layer of adhesive fibers is deposited onto at least one side of the tensioned elastomeric continuous filaments, while simultaneously depositing a fibrous layer of adhesive fibers onto the melt blown fibrous layer and into the nip of the first and second counter rotating accumulator rolls thereby joining the first and second melt blown fibrous layers to the tensioned elastomeric filaments to form a tensioned coherent unified elasticized fabric. The elasticized fabric is elongated through two or more differential velocity draw or stretch rolls thereby additionally stretching the elastomeric filaments, and molecularly orienting at least a portion of the fibers comprising the first and second fibrous layers of melt blown polymeric fibers. The tensioned elasticized fabric is then pin-bonded and relaxed as described above.

Other objects and advantages of the invention will become apparent hereinafter.

Description of the Drawing

Fig. 1 is a side view, shown somewhat schematically, of an apparatus constructed to practice one embodiment of the method of the invention.

Fig. 2 is a side view, also shown somewhat schematically, of an apparatus constructed to practice a modified embodiment of the method of the invention shown in Fig. 1.

Fig. 3 is a side view, also shown somewhat schematically, of an apparatus constructed to practice

an alternative embodiment of the method of the invention.

Fig. 4 is a side view, shown somewhat schematically, of an apparatus constructed to practice a modified embodiment of the method of the invention shown in Fig. 3.

Fig. 5 is a side view, shown schematically, of an apparatus constructed to practice another alternative embodiment of the method of the invention.

Fig. 6 is a side view, also shown schematically, of an apparatus constructed to practice a modified embodiment of the method of the invention shown in Fig. 5.

Fig. 7 is a side view, also shown schematically, of an apparatus constructed to practice another modification of the embodiment of the method of the invention shown in Fig. 5.

Description of the Preferred Embodiment

As used hereinafter, the term "deposit" refers to a deposition of melt blown or sprayed adhesive fibers includes the offset method of transferring a layer of fibrous adhesive from one surface to another.

The term "stabilized" as used herein refers to the stabilizing of an "array" or "filamentary curtain" of melt spun polymeric continuous filaments in a substantially predetermined lineal orientation with a deposition of melt blown or sprayed polymeric fibers or filaments including adhesives of all sprayable types, and which may be deposited onto those continuous filaments. Methods can be used, such as direct deposition onto unsupported areas of continuous filaments between idler rolls, or onto continuous filaments supported on an accumulating surface, which may be foraminous, such as a stationary surface, roll, belt, or a web of any type. The melt blown fibers and

filaments also may be first deposited onto the non-stick surface of a roll, web, or belt and subsequently transferred onto the continuous filaments by contact.

5 The terms "melt blowing and "melt spraying" are herein used interchangeably and defined as the process where thermoplastic polymers are fed through one or more rows of spinnerets or spray nozzles forming molten streams which are then attenuated and fiberized with heated, pressurized air or gas streams. 10 The heated, pressurized air or gas streams elongate or attenuate the molten extrudate, thereby forming fibers and or continuous filaments varying diameters from 0.2 microns or less to diameters of more than 1000 microns, and having lengths ranging from less than about 15 1/8" to continuous filaments having extreme lengths. The air or gas temperatures may range from over 900°F to less than 225°F at the spinneret or spray nozzles depending upon the melt flow rate or the required degradation rate of the thermoplastic polymer or the melt 20 temperature of the hot melt adhesive.

 The term "melt spun" as used herein is defined as the process wherein continuous filaments are prepared by simultaneously spinning a multiple number of continuous filaments of a synthetic polymer such as 25 polypropylene through a multiple number of spinning nozzles or spinnerets, preferably extending in one or more rows. The filaments are drawn pneumatically or mechanically from the spinneret and enter a travel zone which may be confined inside a covered chamber or 30 chimney so as to introduce cooled, ambient, or heated air or other gas at a controlled temperature as required for draw processing or at least partially solidifying the filaments.

 The terms "draw", "drawn", "drawable", "molecularly drawable", and "molecularly oriented" refer 35

to the process which takes place when an unoriented crystalline polymer is subjected to an external stress. That is, it undergoes a rearrangement of the crystalline material wherein it appears that the polymer chains align in the direction of the applied stress at which time the physical properties of the sample change markedly.

The terms "filament", "longitudinal filament", "continuous filament", and "melt spun filament" are herein used interchangeably and are defined for the purposes hereof as melt spun continuous filaments which have not been intentionally broken or cut, and are not limited as to size or shape.

The terms "elastic" and "elasticized" are herein used interchangeably and are used to describe articles which have been made stretchable and contractible with the use of elastomeric materials in their preparation. These articles may be prepared wholly from elastomeric materials or may be comprised of elastomeric materials combined with relatively non-elastic materials.

The continuous filaments referred to herein are prepared by simultaneously spinning a multiple number of continuous filaments of a synthetic polymer such as a polypropylene or an elastomeric polymer through a multiple number of spinning nozzles or spinnerets, preferably extending in one or more rows. Upon exiting the spinnerets the filaments enter a controlled temperature chamber and are drawn away from the spinneret orifice at a greater rate than the rate of extrusion. Thus is effected a substantial draw down of the filaments in the molten state prior to solidification thereof. The solidified filaments having a low degree of molecular orientation are then subjected to a mechanical draw down with draw rolls

under closely controlled temperature and velocity conditions thereby imparting a much higher degree of molecular orientation to the continuous filaments.

5 The melt blowing of adhesive fibers is performed by the same technique as in the above-identified article by Wentz. The fibers have diameters ranging from less than 0.5 microns to more than about 250 microns. These adhesive fibers are made by extruding a molten thermoplastic adhesive material
10 through a plurality of fine die capillaries as a molten extrudate of filaments into a high velocity gas stream which attenuates the filaments of molten adhesive material to reduce their diameter to the above stated range in the formation of microfibers or filaments. Any fiberizable hot melt adhesive material is
15 suitable in the formation of adhesive fibers to be used in the intermingling and the joining of stratified fibrous fabrics. Elastomeric adhesives, pressure sensitive adhesives, pressure sensitive hot melts, viscoelastic hot melts, self-adhering elastic materials and conventional hot melt adhesives are some of
20 the adhesives suitable for forming adhesive fibers. It is to be understood, however, that the present invention is not to be limited to these specific adhesives.
25

As has been previously stated, the melt blown adhesive fibers do not stiffen the fibrous stratified fabrics as do the roller applied or coated adhesives. These latter adhesives often fill crevices
30 and interstices between the fibers of the fibrous layer or web and, after solidification, bind groups of fibers together, which stiffens the fibrous layer and has a deleterious effect on the hand and drape. The melt blown adhesive fibers on the other hand act as do
35 the fibers of the layered fibrous web and not as

sprays such as paint sprays, wherein small droplets of paint are emitted from a gun. The melt blown fibers, being flexible and of small diameter, are turbulently entangled with the fibrous web fibers and form bonds at their intersections with these fibers. These intersectional adhesive bonds behave similarly to fusion bonds with no noticeable stiffness of the composite fabric. They also provide the additional feature that the elastomeric adhesive fibers stretch or elongate under stress.

Other materials for use in forming indepth, joined, stratified webs such as those disclosed here are polyolefins such as polypropylene, polyethylene, polybutane, polymethylidene, ethylenepropylene copolymers; polyamides such as polyhexamethylene adipamide, poly-(oc-caproamide), polyhexamethylene sebacamide, polyvinyls such as polystyrene, thermoplastic elastomers such as polyurethanes, other thermoplastic polymers such as polytrifluorochloroethylene and mixtures thereof; as well as mixtures of these thermoplastic polymers and copolymers; ethylene vinyl acetate polymers, synthetic polymers comprising 40% or more of polyurethane; polyetheresters; polyetherurethane; polyamide elastomeric materials; and polyester elastomeric materials S-EB-S Kraton "G" Block copolymers and Kraton GX 1657 Block copolymers as furnished by Shell Chemical Company; polyester elastomeric materials under the trade name "Hytrel" from the Dupont Company; polyurethane elastomeric materials under the trade name "Estane" from B. F. Goodrich and Company and polyamide elastomeric material under the trade name "Pebax" from Rilsam Company, including copolymers, blends or various formulations thereof with other materials. Also included are viscoelastic hot melt pressure sensitive adhesives such as "Fullastic" sup-

plied by H.B. Fuller and Company and other hot melt adhesives including pressure sensitive adhesives. Any of the fiber forming thermoplastic polymers including fiber forming hot melt adhesives, pressure sensitive adhesives, and viscoelastic hot melt pressure sensitive adhesives can be used for stabilizing the web or bonding the stabilized web to one or more cellulose webs, wood pulp webs, melt blown fibrous mats, or for laminating and bonding two or more stabilized webs to from laminates. The instant invention is not limited by the above polymers, for any thermoplastic polymer, co-polymer or mixture thereof capable of being melt blown into fibers or filaments is suitable. Any of the thermoplastic elastomers which are capable of being melt blown or melt spun are suitable for the manufacture of stretchable fabrics.

Unless the context requires otherwise, the continuous filaments used herein to form a curtain of continuous filaments can be of many materials, natural or manmade, ranging from textile threads or yarns composed of cotton, rayon, hemp, etc. to thermoplastic polymers. This invention is not limited to the use of any particular fiber, but can take advantage of many properties of different fibers. A curtain of continuous filaments or threads using multifilament threads of rayon or nylon is readily stabilized by depositing a layer of molten melt blown fibers or filaments on this continuous filamentary web. Upon cooling, the molten melt blown filaments become tacky and self-bond to the continuous rayon or nylon threads.

In the preferred embodiments, thermoplastic melt spun continuous filaments are used which involve continuously extruding a thermoplastic polymer through a spinneret thereby forming a curtain of individual filaments. Among the many thermoplastic polymers

suitable for the continuous filaments are polyolefins such as polyethylene and polypropylene; polyamides, polyesters such as polyethylene terephthalate; thermoplastic elastomers such as polyurethanes; thermoplastic co-polymers; mixtures of thermoplastic polymers; co-polymers and mixtures of co-polymers; as well as the previously listed materials used herein for the melt blown fibers and filaments. However, the present invention is not limited to these materials, for any melt spinnable polymer is suitable, including all adhesive materials and spun bonded materials listed herein, and melt blown materials. Other spinnable thermoplastic elastomers which are suitable for stretchable fabrics include but are not limited to polyester based polyurethane, and polyester type polyurethane polymeric fiber forming elastomers such as Texin 480A supplied by Mobay Chemical Company.

It will be understood that this invention is not to be limited to the aforementioned materials. On the contrary, it is intended that all fiberizable thermoplastic polymers, co-polymers and blends thereof, in addition to wood pulp or cellulose fibers and including staple fibers and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims are to be included.

Referring now to Fig. 1, there is shown an apparatus 10 for practicing the invention according to a preferred embodiment of the method of the invention. According to this embodiment, the process for producing an elasticized fabric includes the forming of one or more arrays 12 of elastomeric continuous filaments from an elastomeric melt spun extrusion die 14 and at the same time forming one or more arrays 16 of elongatable but relatively non-elastic continuous filaments from a non-elastic polymer melt spun extrusion

die 18. In this embodiment, both the elastomeric filaments 12 and the non-elastic filaments 16 are separately passed through respective sets of temperature controlled feed rolls 20 and 22 and maintained under tension. This has the effect of molecularly orienting the non-elastic filaments of array 16. From the feed rolls 20 and 22, the elastomeric filaments 12 and the non-elastic filaments 16 are joined together at a dancer roll 24 which assists in maintaining tension on both sets of filaments. From the dancer roll 24, both sets of filaments then pass around a first accumulating roll 26 which rotates at a predetermined first peripheral velocity. While the elastic filaments 12 and non-elastic filaments 16 are on the accumulating roll 26, melt blown adhesive fibers 28, from a melt blown adhesive die 30 are applied to the outer surface of the filaments. At least one layer of melt blown fibers 32 is then deposited onto the adhesive fibers 28, by a melt blown fiber die 34. This deposit has the effect of stabilizing the elastomeric filaments in their predetermined laydown orientation, producing a stabilized web 35. Optionally, a prefabricated web 36 may be applied over the melt blown fibrous layer formed by fibers 32. The prefabricated web 36 may be any suitable prefabricated web including but not limited to dry or wet laid webs, spun bonded webs, melt blown webs, air laid webs, hydroentangled webs, film, spun laced webs, fibrillated films, needle punched webs, high loft fabrics, and stabilized, non-random laid, continuous filament webs as described in Sabee '064.

This stabilized web 35 then approaches a second adjacent accumulating roll 38 which is rotating at a second peripheral velocity greater than the peripheral velocity of the first accumulating roll 26.

This difference in velocities has the effect of stretching the stabilized web 35, further molecularly orienting the non-elastic filaments 16 of the web and molecularly orienting at least some of the fibers 32 comprising the melt blown fibrous layer, thus forming an elongated elasticized web.

At that point, with the web wrapping around a second accumulating roll 38 in the opposite direction, the opposite side of the web is exposed. Adhesive fibers 40 from a melt blown adhesive die 42 and a layer of melt blown polymeric fibers 44 from a melt blown fiber die 46 are deposited onto the web. Optionally, again, a prefabricated web 48, of any of the materials listed above in connection with prefabricated web 36, may be applied over the second fibrous layer 44. The resulting elongated elasticized fabric is then fed through a pair of temperature controlled thermal pin bonding rolls 50 having projecting pins 52 which further bond the fabric with autogenous bonds. Thereafter, the fabric is relaxed, which permits the formation of corrugations, wrinkles or gathers in the web, as shown in the drawing figure. This "gathered" web is accumulated on a final roll 54, such as by means of a two-drum winder 55, for a later distribution or use elsewhere.

The embodiment of the method being performed in Fig. 2 is similar, with a few slight modifications. In particular, only an array of elastomeric filaments 12 from an elastomeric melt blown extrusion die 14 are being formed at the beginning. This array of elastomeric filaments passes through a set of feed rolls 20, similar to the method shown in Fig. 1. As there shown, these feed rolls 20, in combination with other smaller rolls 56, 58 and 60 downstream, exert a tension on the elastomeric filaments 12. Optionally, a

5 prefabricated web 62, of any of the materials listed
above in connection with prefabricated web 36, may be
applied to the elastomeric filaments 12 by means of
melt blown adhesive 64 from a melt blown adhesive die
66. As can be seen from Fig. 2, the elastomeric fila-
ments then pass around an accumulating roll 68, held
against that roll by rolls 56 and 58, referred to
above. As the filament array 12 passes around roll
10 68, the fibrous layer of adhesive fibers 28 from the
melt blown adhesive die 30, and the fibrous web of
polymeric fibers 32 from the melt blown fiber die 34,
are applied to the outer side of the elastomeric fila-
ments 12. Thereafter, as indicated in connection with
Fig. 1, the resulting fabric is pin bonded and re-
15 laxated, thereby forming corrugations, wrinkles or gath-
ers in the fabric, as the fabric is accumulated by the
two-drum winder 55 at final roll 54.

Referring now to Fig. 3, there is shown ap-
paratus 70 for practicing a different embodiment of
20 the method of the invention. As can be seen in that
figure, an array 72 of continuous relatively elasto-
meric filaments is formed by an extrusion die 73, and
an array 74 of elongatable relatively non-elastic con-
tinuous filaments are formed by an extrusion die 76.
25 At the same time, a fibrous layer 78 of melt blown
polymeric fibers 80 is being deposited onto the tem-
perature controlled surface of one or both of two ac-
cumulator rolls 82 by melt blown fiber dies 84. After
formation of the elastic filaments 72 and non-elastic
30 filaments 74, both sets of filaments are passed to-
gether between a set of chilled feed rolls 86 and into
the nip of a pair of chilled squeeze rolls 88. At the
same time, the fibrous layers 78 of melt blown poly-
meric fibers 80 are also fed into the same nip. If
35 two such layers are provided, one is fed into the nip

on each side of the filamentary curtain 90 formed by the combination of the elastic filaments 72 and non-elastic filaments 74. Just before the fibrous layers 78 are joined to the filamentary curtain 90, a fibrous layer of melt blown adhesive fibers 92 is applied both to the filamentary curtain 90 and to the side of the layers 88 which will eventually be facing toward the filamentary curtain 90, by means of melt blown adhesive dies 94. Thereafter, the assembled fabric 96 is pin bonded by pin bonding rolls 50 and relaxed to permit the formation of corrugations, wrinkles or gathers in the fabric and kinks, curls and undulations in the non-elastic continuous filaments, as the fabric is accumulated about final roll 54 on the two-drum winder 55.

Fig. 4 shows an apparatus for practicing a method only slightly modified from that described above in connection with Fig. 3. The optional addition of prefabricated webs 36, 48 are provided for, as was the case in the apparatus shown in Fig. 1. More important, the fabric 96, though formed in basically the same way as described above in connection with Fig. 3, is not subjected to tension prior to pin bonding at rolls 50. Rather, it is relaxed at first, and subjected to tension by draw rolls 98 only after the pin bonding step. These draw rolls 98 have the effect of incrementally drawing and elongating the unified fabric 96, thereby stretching the elastomeric filaments 72 and elongating and molecularly orienting at least some of the fibers 80 of the fibrous layers 78. At least a portion of this incremental elongation is provided by a pair of incremental elongation rolls 100. Thereafter, the fabric is again subjected to pin bonding, such as by rolls 50a, and relaxation so as to result in corrugations, wrinkles or gathers in the

melt blown fibrous layers 78 and kinks, curls, undulations or corrugations in the non-elastic continuous filaments 74, as the fabric is accumulated about final roll 54 on two-drum winder 55. Note that the pins of pin bonding rolls 50a are shown to be located on the side of the fabric opposite the pins of pin bonding rolls 50. While not necessary, this reversal may be advantageous in obtaining a tenacious bonding of the fabric.

Shown in Fig. 5 is apparatus for practicing another embodiment of the method of the invention. Here again, similar to the apparatus shown in Fig. 1, extrusion dies 14 and 18 are shown for producing elastomeric filaments 12 and non-elastic filaments 16. Both the elastomeric filaments 12 and the non-elastic filaments 16 may be passed through respective feed roll sets 20 and 22. Simultaneously, layers 78 of melt blown fibers 80 are formed on two oppositely rotating accumulating rolls 106 and 108. In this embodiment, however, a prefabricated web 102, of any of the materials listed above in connection with prefabricated web 36, may be laid beneath one of the fibrous layers 78. In addition, another prefabricated web 104, also of any of the materials listed above in connection with prefabricated web 36, may be applied between the other fibrous layer 78 of melt blown polymeric fibers and the filamentary curtain formed by elastomeric filaments 12 and non-elastic filaments 16. All of these layers are then fed into the nip between the two accumulating rolls 106 and 108, thereby joining all of the above indicated layers, webs and curtains to form a tensioned, coherent, unified, elasticized fabric 110. This fabric 110 then passes through the nip between a pressure roll 112 and one of the accumulating rolls 108, and then between a pair of tempera-

ture controlled feed rolls 114. Thereafter, the tension on the fabric is released, relaxing the fabric and thereby forming corrugations, wrinkles or gathers in the melt blown fibrous layer or layers 78 and kinks, curls and undulations in the non-elastic continuous filaments 16, as the fabric is accumulated by two-drum winder 55 about the final roll 54.

Fig. 6 shows a modification to the embodiment practiced in Fig. 5. The apparatus in Fig. 6 arrives at the same fabric 110 as referred to in Fig. 5, except that the elastomeric filaments 12 and non-elastomeric filaments 16 are not subjected to tension prior to entering the nip between accumulating rolls 104 and 108. This can be seen by the fact that the feed roll sets 20 and 22 are open, and do not bear upon the respective filamentary curtains. Thereafter, however, after the feed rolls 114, the fabric 110 is subjected to tension by a set of differential velocity draw or stretch rolls 116, which stretch the elastomeric filaments 12 and molecularly orient at least a portion of the fibers of the melt blown fibrous layers 78. Thereafter, again, the fabric is relaxed, thereby forming corrugations, wrinkles or gathers in the melt blown fibrous layers 78. Alternatively, or in addition, the fabric may be subjected to incremental elongation by incremental stretch rolls 118.

In another alternative to the embodiment shown practiced in Fig. 5, Fig. 7 shows a single accumulator roll 108, about which the single layer 78 of polymeric fibers 80 is applied in addition to elastomeric filaments 12 and non-elastic filaments 16. Also, optionally, a prefabricated web 104 may be applied between the fibrous layer 78 and the filamentary curtain formed by the filaments 12, 16. The fabric 120 thus formed is subjected thereafter to stretching by

means of differential velocity draw or stretch rolls 116, and optionally corrugated rolls 118 before being pin bonded by pin bonding rolls 50 as referred to above. Thereafter, as usual, the fabric is relaxed and permitted to form its corrugations, gathers and so on.

In another embodiment, any one or all of the continuous filaments 12, 16, 72, 74 referred to herein are replaced by a cross-laid laminate of nonrandom-laid continuous filaments, prepared by a machine as disclosed in Sabee '064, incorporated hereinabove. According to the disclosure of that patent, at least one curtain of continuous filaments oriented in a first direction is joined to another curtain of continuous filaments oriented in a second direction transverse to the first direction. The cross-laid laminate may be additionally stabilized by the deposition of melt blown fibers as disclosed therein. Moreover, any reference to a prefabricated web 36, 48, 62, 102, 104 should be taken to optionally include a prefabricated web of this cross-laid laminate.

While the method and apparatus hereinbefore described is effectively adapted to fulfill the aforesaid objects, it is to be understood that the invention is not intended to be limited to the specific preferred embodiment of the method of forming elastici- zed fabric with continuous filaments set forth above. Rather, it is to be taken as including all reasonable equivalents within the scope of the following claims.

I claim:

1. A process for producing an elasticized fabric comprising relatively elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments wherein said elastomeric filaments are under tension and wherein said non-elastic filaments are molecularly oriented, onto a first accumulating roll having a first peripheral velocity;

10 b. depositing at least one melt blown fibrous layer onto a first side of said array of elastomeric filaments thereby stabilizing the elastomeric filaments in their predetermined laydown orientation;

15 c. elongating said stabilizing web between said first accumulating roll and a second adjacent accumulating roll having a second peripheral velocity greater than said first peripheral velocity, thereby stretching the elastomeric filaments, further molecularly orienting said non-elastic filaments and molecularly orienting at least some fibers comprising said melt blown fibrous layer, thereby forming a elongated elasticized web;

20 d. depositing at least one fibrous layer of adhesive fibers onto the second side of said tensioned elasticized web while simultaneously depositing a second fibrous web onto said fibrous layer of adhesive fibers, thereby forming a tensioned, coherent, unified elasticized fabric;

25 e. feeding said tensioned, coherent, unified elasticized fabric through a pair of temperature controlled thermal pin bonding rolls having projecting pins which further bond said stretched elasticized

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35 fabric with autogenous bonds; and

f. relaxing said tensioned elasticized fabric thereby forming gathers in said pin-bonded fibrous web.

2. The process for producing an elasticized fabric comprising relatively elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments wherein said elastomeric filaments are under tension and wherein said non-elastic filaments
10 are molecularly oriented, while simultaneously depositing one or more fibrous layers of melt blown polymeric fibers onto one or more temperature controlled accumulating surfaces;

15 b. depositing at least one fibrous layer of adhesive fibers onto at least one side of said tensioned elastomeric filaments and said non-elastic filaments while simultaneously feeding one or more melt blown fibrous webs, with said elastomeric filaments and said non-elastic filaments, between a pair of
20 pressurized temperature controlled squeeze rolls, thereby joining said one or more melt blown fibrous webs, said elastomeric filaments and said non-elastic filaments and forming a tensioned coherent unified elasticized fabric; and

25 c. relaxing said unified fabric thereby forming gathers in said melt blown fibrous web and undulations in said non-elastic filaments.

3. The process for producing an elasticized fabric comprising relatively elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments;

 b. depositing at least one melt blown fibrous layer onto one or more accumulating surfaces to form at least one melt blown fibrous web;

10 c. depositing at least one melt blown layer of adhesive fibers onto at least one side of said elastomeric filaments to stabilize their laydown orientation;

 d. feeding at least one melt blown fibrous web and said stabilized elastomeric filaments between a pair of pressurized temperature controlled squeeze rolls, thereby joining said one or more melt blown fibrous webs and said elastomeric filaments and forming a coherent elasticized unified fabric;

20 e. incrementally drawing and elongating said unified fabric thereby stretching said elastomeric filaments and molecularly orienting at least some fibers of said melt blown fibrous web;

 f. feeding said stretched unified elasticized fabric through a pair of pressurized heated thermal pin bonding rolls wherein the projecting pins further bond said tensioned unified fabric with autogenous bonds; and

30 g. relaxing said tensioned unified fabric thereby forming gathers in said melt blown fibrous web and undulations in said non-elastic filaments.

 4. The process for producing an elasticized fabric comprising relatively elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments wherein said elastomeric filaments are

under tension and wherein said non-elastic filaments
10 are molecularly oriented, while simultaneously depositing one or more fibrous layers of melt blown polymeric fibers onto one or more accumulating surfaces;

b. depositing at least one fibrous layer of
15 adhesive fibers onto at least one side of said tensioned elastomeric filaments and said molecularly oriented non-elastic filaments;

c. feeding said tensioned elastomeric filaments, at least one of said non-elastic filaments, and
20 said at least one fibrous layer, into the nip of two oppositely rotating accumulating rolls thereby joining said at least one fibrous layers, said non-elastic filaments and said elastomeric filaments to form a tensioned coherent unified elasticized fabric; and

d. relaxing said unified fabric thereby
25 forming gathers in said melt blown fibrous web and undulations in said non-elastic filaments.

5. The process for producing an elasticized fabric comprising elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments;

b. depositing one or more melt blown fibrous layers onto one or more accumulating surfaces to
form one or more melt blown polymeric fibrous webs;

10 c. depositing at least one fibrous layer of adhesive fibers onto at least one side of said elastomeric continuous filaments and onto at least one side of one or more fibrous webs;

d. feeding said elastomeric filaments, and
15 said one or more fibrous webs, into the nip of two rotating accumulating rolls to join said one or more fibrous webs to said elastomeric filaments, thereby

forming a coherent unified elasticized fabric;

20 e. elongating said elasticized fabric through two or more differential velocity draw or stretch rolls thereby stretching said elastomeric filaments, and molecularly orienting at least a portion of the fibers of said fibrous web; and

25 f. relaxing said tensioned elasticized fabric thereby forming gathers in said fibrous webs.

6. The process for producing an elasticized fabric comprising elastomeric continuous filaments joined to one or more non-woven webs or filaments, said process comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments and one or more arrays of elongatable but relatively non-elastic continuous filaments while simultaneously depositing one or more melt blown fibrous webs onto one or more accumulating surfaces;

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b. depositing at least one fibrous layer of adhesive fibers onto at least one side of said elastomeric filaments, onto at least one side of said non-elastic filaments, onto at least one side of said one or more melt blown fibrous webs, and into the nip of a pair of temperature controlled nip rolls;

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c. feeding said elastomeric filaments, said non-elastic filaments and said one or more fibrous webs into the nip of two counter rotating accumulating rolls thereby joining said one or more fibrous webs, said elastomeric filaments and said non-elastic filaments, thereby forming a coherent unified coherent elasticized fabric;

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d. elongating said elasticized fabric through two or more differential velocity draw or stretch rolls thereby stretching said elastomeric filaments, elongating and molecularly orienting the non-

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elastic filaments, and longating said fibrous web while simultaneously molecularly orienting at least a portion of the fibers comprising said fibrous web;

e. feeding the tensioned elasticized fabric through a pair of temperature controlled thermal pin bonding rolls wherein the projecting pins further bond said stretched elasticized fabric with autogenous bonds; and

f. relaxing said unified fabric thereby forming undulations in said non-elastic filaments and forming gathers in said fibrous web.

7. The process for producing an elasticized fabric comprising elastomeric continuous filaments joined to one or more non-woven webs or filaments, said process comprising the steps of:

a. forming one or more arrays of relatively elastomeric continuous filaments onto an accumulator roll, wherein said elastomeric filaments are under tension;

b. depositing at least one fibrous layer of adhesive fibers onto at least one side of said tensioned elastomeric filaments;

c. depositing one or more fibrous webs of polymeric fibers onto at least one side of said fibrous layer of adhesive fibers forming a coherent tensioned elasticized fabric;

d. feeding said coherent tensioned elasticized fabric through a pair of thermal pin bonding embossing rolls to further bond said tensioned elasticized fabric with autogenous bonds; and

e. relaxing said tensioned unified fabric thereby forming gathers in said fibrous web.

8. The process for producing an elasticized fabric comprising elastomeric continuous filaments joined to one or more non-woven webs, said process

comprising the steps of:

5 a. forming one or more arrays of relatively elastomeric continuous filaments under tension while simultaneously depositing first and second fibrous layers of melt blown polymeric fibers onto first and second accumulating surfaces;

10 b. depositing a first fibrous layer of adhesive fibers onto at least one side of said tensioned elastomeric filaments, while simultaneously depositing a second fibrous layer of adhesive fibers onto said melt blown fibrous layers and into the nip of said
15 first and second counter rotating accumulator rolls, thereby joining said first and second melt blown fibrous layers to said tensioned elastomeric filaments to form a tensioned coherent unified elasticized fabric;

20 c. elongating said elasticized fabric through two or more differential velocity draw or stretch rolls thereby additionally stretching said elastomeric continuous filaments, and molecularly orienting at least a portion of the fibers comprising
25 said first and second fibrous layers of melt blown polymeric fibers;

 d. feeding said elongated elasticized fabric through a pair of temperature controlled thermal pin bonding rolls wherein the projecting pins further
30 bond said elongated fabric with autogenous bonds; and

 e. relaxing said elongated elasticized fabric thereby forming gathers in said melt blown polymeric fibrous layers.

9. The process for producing an elasticized fabric comprising elastomeric continuous filaments joined to one or more non-woven webs, said process comprising the steps of:

5 a. forming one or more arrays of relatively

elastomeric continuous filaments onto an accumulator roll, thus creating relaxed elastomeric filaments;

b. depositing at least one fibrous layer of adhesive fibers onto at least one side of said relaxed elastomeric continuous filaments;

c. depositing one or more fibrous webs of polymeric fibers onto at least one side of said fibrous layer of adhesive fibers forming a coherent relaxed elasticized fabric;

d. elongating said elasticized fabric by passing said fabric around two or more differential velocity or stretch rolls thereby stretching said elastomeric filaments and elongating said elastomeric filaments while simultaneously molecularly orienting at least a portion of the fibers comprising said polymeric fibrous web;

e. feeding said elongated elasticized fabric through a pair of temperature controlled thermal pin bonding rolls wherein the projecting pins further bond said elongated elasticized fabric with autogenous bonds; and

f. relaxing said pin-bonded elasticized fabric thereby forming gathers in said polymeric fibrous webs.

10. A non-woven fabric comprising:

a multiplicity of continuous filaments at least partially of an elastomeric polymer, oriented substantially longitudinally;

a multiplicity of melt blown fibers deposited on said longitudinal continuous filaments, said melt blown fibers forming bonds at least at some of their intersections with said longitudinal filaments to thereby stabilize and fix said longitudinal filaments in the substantially longitudinal orientation to form a stabilized web; and

at least one prefabricated web joined to said stabilized web.

11. A non-woven fabric comprising:

a first plurality of continuous filaments at least partially of an elastomeric polymer, oriented substantially longitudinally;

5 a second plurality of continuous filaments at least partially of an elastomeric polymer, oriented substantially parallel to each other and deposited onto said first plurality in a transverse orientation and in a face-to-face relationship; and

10 a plurality of melt blown fibers deposited at least on one side of said longitudinal and transverse continuous filaments, said melt blown fibers forming bonds at least at some of their intersections with said longitudinal and transverse filaments to
15 thereby stabilize and fix said filaments in their respective orientations.

12. A composite elasticized nonwoven fabric comprising continuous filaments, having at least one deposition of melt blown fibers, joined to at least one gathered web.

13. A nonwoven fabric according to any one of claims 10, 11 and 12, wherein at least some of said continuous filaments are non-elastic but elongatable.

14. A nonwoven fabric according to any one of claims 10, 11 and 12, wherein at least some of said melt blown fibers are elastomeric.

15. A nonwoven fabric according to any one of claims 10, 11 and 12, wherein at least some of said melt blown fibers are nonelastic but elongatable.

16. A nonwoven fabric according to any one of claims 10, 11 and 12, wherein at least some of said melt blown fibers are adhesive fibers.

17. A nonwoven fabric according to claim 10

5 wher in said prefabricated web is chosen from the group consisting of: fibrillated film, high loft fabric, dry laid web, wet laid web, film, spun bonded web, air laid web, melt blown web, spun laced web, hydroentangled web, needle punched web or stabilized continuous filament non-random laid web.

5 18. A nonwoven fabric according to claim 12 wherein said gathered web is chosen from the group consisting of: fibrillated film, high loft fabric, dry laid web, wet laid web, film, spun bonded web, air laid web, melt blown web, spun laced web, hydroentangled web, needle punched web or stabilized continuous filament non-random laid web.

5 19. A nonwoven elasticized fabric comprising a multiplicity of non-random laid continuous filaments joined to at least one deposition of melt blown fibers by an intermediate deposition of melt blown adhesive fibers, and having gathers in said at least one deposition of melt blown fibers.

20. A nonwoven elasticized fabric as recited in claim 19 wherein said at least one deposition of melt blown fibers is a prefabricated web.

21. A nonwoven elasticized fabric as recited in claim 19 wherein at least some of the non-random laid continuous filaments are non-elastic but elongatable.

22. A nonwoven elasticized fabric as recited in claim 19 further comprising a pattern of spot autogenous fusion bonds.

23. A nonwoven elasticized fabric as recited in claim 19 further comprising at least one prefabricated web in addition to said at least deposition of melt blown fibers.

24. A nonwoven elasticized fabric as recited in claim 23 wherein said at least one prefabricated

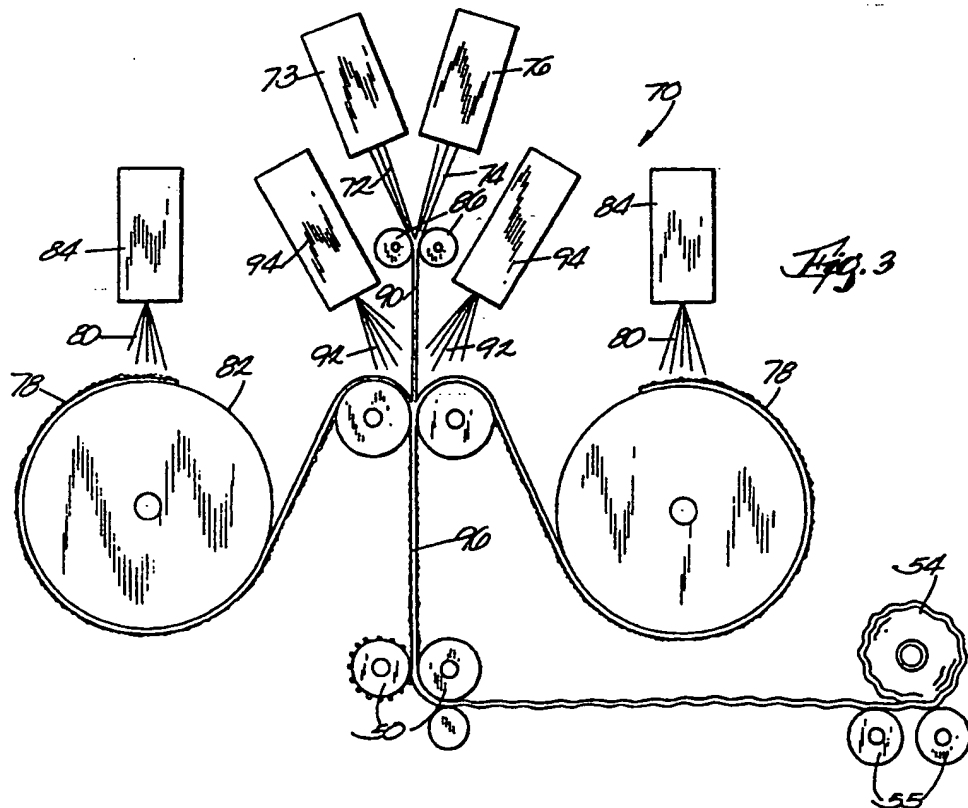
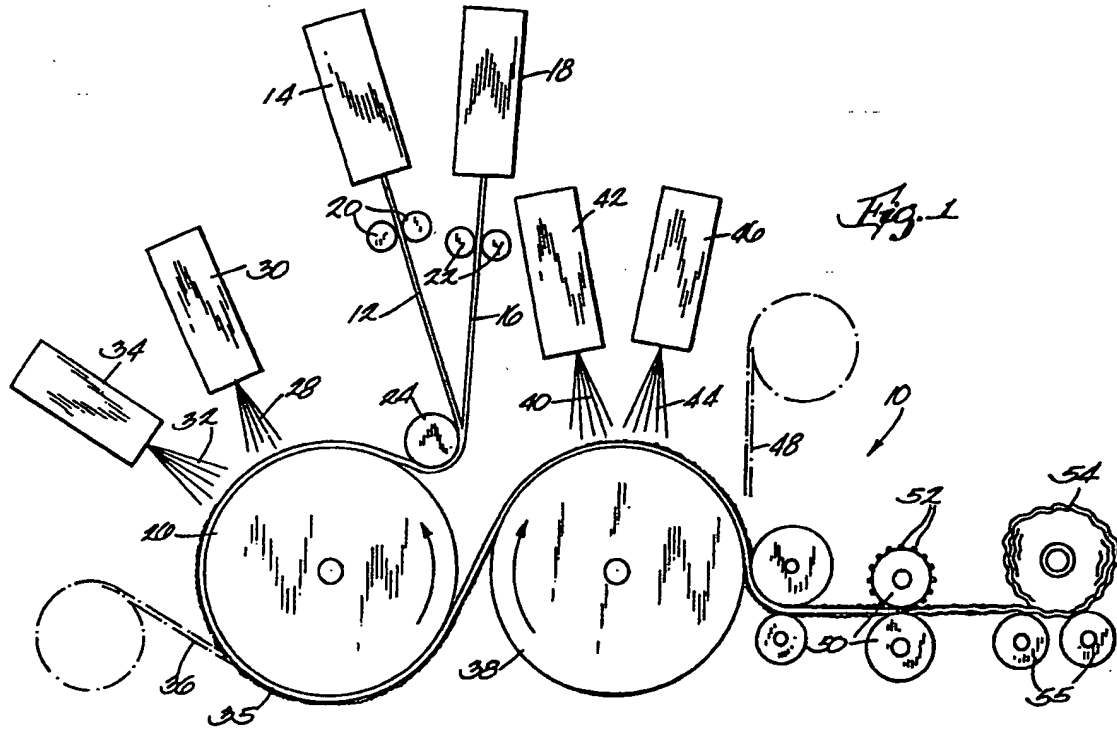
web has gathers.

25. A nonwoven elasticized fabric as recited in claim 21 wherein said non-elastic but elongatable continuous filaments are molecularly oriented.

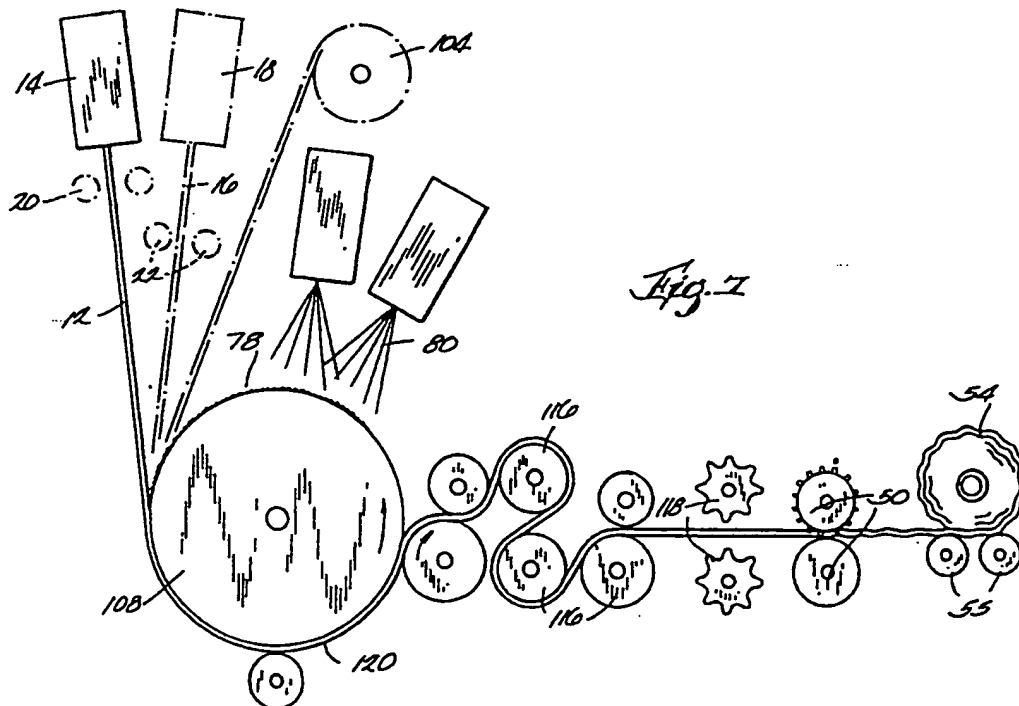
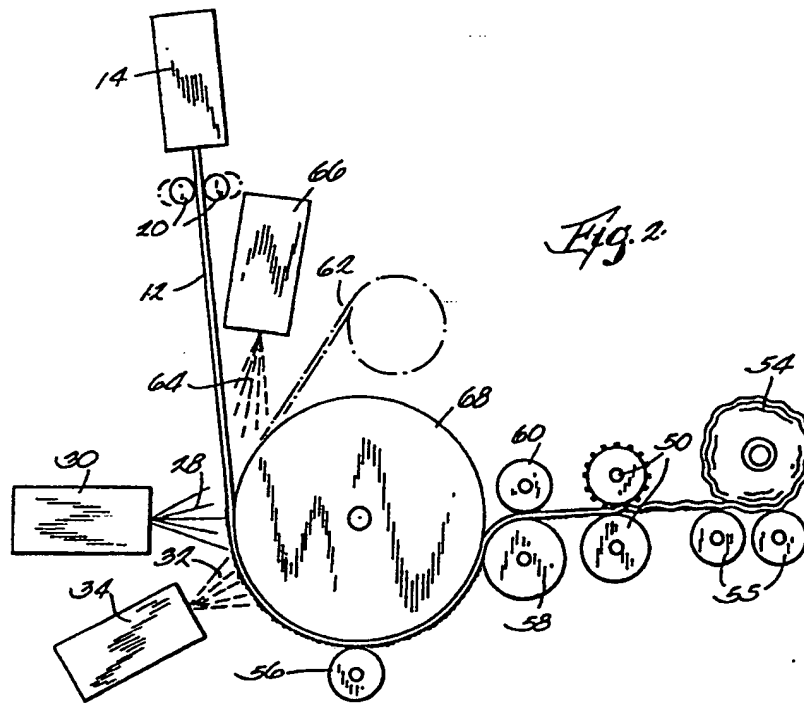
26. A nonwoven elasticized fabric as recited in claim 19 wherein said melt blown fibers are elastomeric.

27. A nonwoven elasticized fabric as recited in claim 19 wherein at least some of said non-random laid continuous filaments are oriented transverse to some other of said non-random laid continuous filaments.

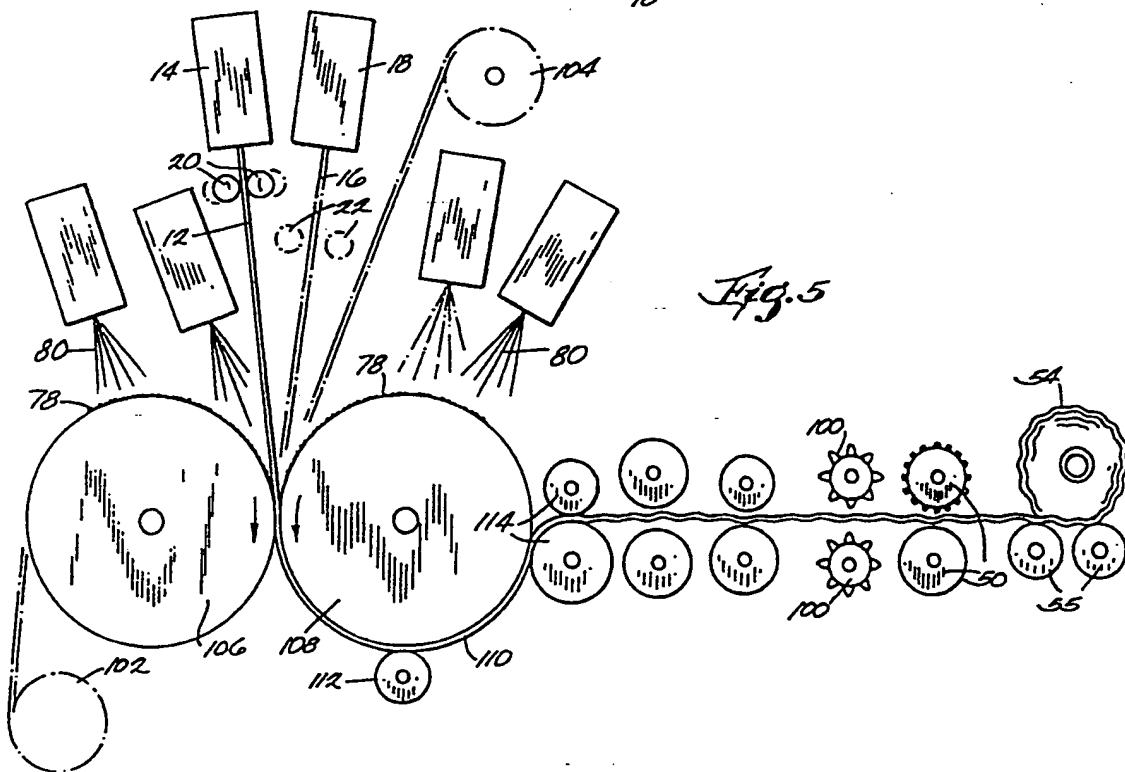
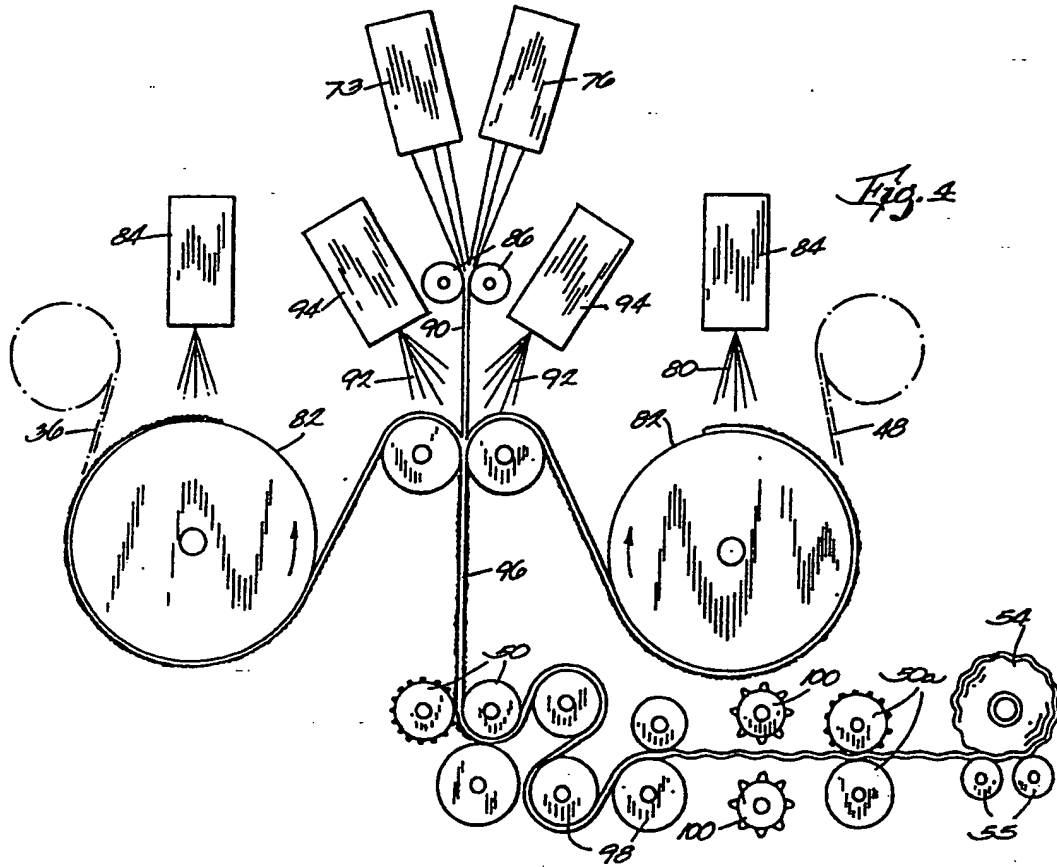
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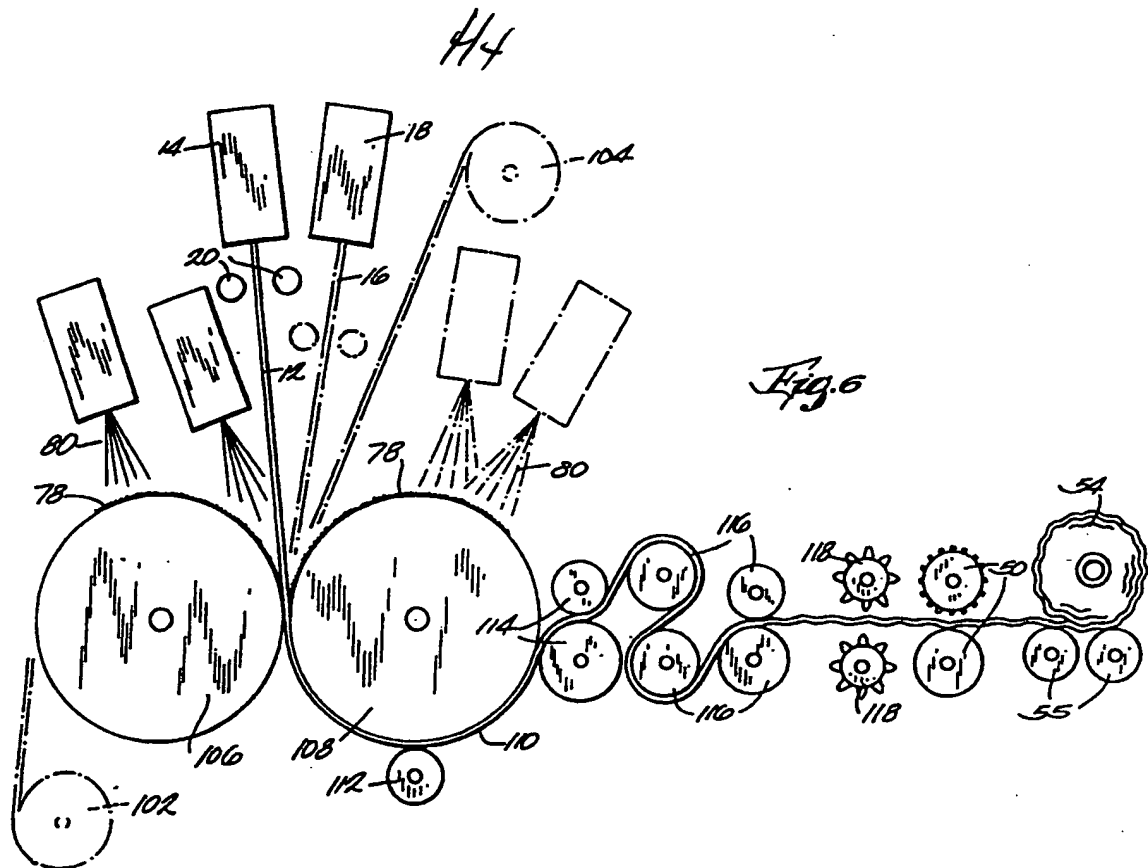


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INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/06925

| | | |
|--|--|-------------------------------------|
| I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * | | |
| According to International Patent Classification (IPC) or to both National Classification and IPC IPC(5): B32B 5/26; D04H 5/00, 13/00 US CL : 156/161; 428/288; 428/298 | | |
| II. FIELDS SEARCHED | | |
| Minimum Documentation Searched ⁷ | | |
| Classification System | Classification Symbols | |
| U.S. | 156/161, 163, 164, 229, 495, 167; 428/288, 296, 298; 604/366, 370, 372 | |
| Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸ | | |
| | | |
| III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ | | |
| Category ¹⁰ | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ |
| Y | US, A, 4,209,563 (SISSON) 24 JUNE 1980 See the entire document. | 1-27 |
| Y | US, A, 3,912,567 (SCHWARTZ) 14 OCTOBER 1975 See the entire document. | 1-27 |
| Y | US, A, 3,949 (SABEE ET AL.) 06 APRIL 1976 See the entire document. | 1-27 |
| Y | US, A, 4,013,816 (SABEE ET AL.) 22 MARCH 1977 See the entire document. | 1-27 |
| Y | US, A, 4,657,802 (MORMAN) 14 APRIL 1987 See the entire document. | 1-27 |
| Y | US, A, 4,605,458 (NAKAMURA) 12 AUGUST 1986 See the entire document. | 1-27 |
| Y | US, A, 4,606,964 (WIDEMAN) 19 AUGUST 1986 See the entire document. | 1-27 |
| Y | US, A, 4,692,368 (TAYLOR, ET AL.) 08 SEPTEMBER 1987 See the entire document. | 1-27 |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div> | | |
| IV. CERTIFICATION | | |
| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report | |
| 05 DECEMBER 1991 | 18 DEC 1991 | |
| International Searching Authority | Signature of Authorized Officer | |
| ISA/US | JEFF H. AFTERGUT PCT/US91/06925 INTERNATIONAL PATENT DIVISION | |

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

Y

US, A, 4,720,415 (VANDER WIELEN, ET AL.) 19
JANUARY 1988, see the entire document.

1-27

V ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____ because they relate to subject matter ^{1,2} not required to be searched by this Authority, namely:2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ^{1,2}, specifically:3. ☐ Claim numbers _____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:4. ☐ As all searchable claims could be searched without effort just by paying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.